European Union Aviation Safety Agency

COMMENT RESPONSE DOCUMENT

EASA CRD of ESF on CS-E 810 – Compressor and Turbine Blade Failure / Fan Integrally-Bladed Rotor (IBR) Airfoil Release

[Published on 11 February 2019 and officially closed for comments on 11 March 2019]

Commenter 1: Rolls Royce

Page(s)	All
Paragraph	General
Comment #1	ESF findings line with feedback provided by AIAA working group looking into FAR33.94 topics; key additions being clarification of minimum 80% release & requirements to consider impacts, defects and also HCF effects as defined by CS-E 650.
EASA position	Agreed
EASA response and proposed text	No changes have been made to the Final ESF in response to this comment.

Commenter 2: Rolls Royce

Page(s)	2
Paragraph	EASA Position

Comment #2	Currently it says “The establishment of a life for the fan IBR airfoil section under the demonstrated release location using a procedure approved by the Agency”. To avoid any mis-understanding, it should be clear this includes down to and including the inner annulus flow path.
EASA position	Agreed
EASA response and proposed text	The sentences “under the demonstrated release location” are modified to clarify that the affected area is “down to and including the inner annulus flow path”, and the generic term “Critical Airfoil Section” is introduced and defined in the ESF as “the fan IBR airfoil under the demonstrated blade release location down to and including the inner annulus flow path”

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Commenter 3: Rolls Royce

Page(s)	3
Paragraph	EASA Position
Comment #3	The meaning of sentence "All attributes considered redundant are mandatory, applicable to each airfoil, and permanent." is not clear to the reader.
EASA position	Agreed
EASA response and proposed text	The sentence is reworded to clarify that an appropriate level of attribute redundancy needs to be established and agreed with EASA. “All attributes considered redundant are mandatory, applicable to each airfoil, and permanent.” replaced by: “Appropriate attributes redundancy shall be defined and agreed with EASA.”

Commenter 4: Rolls Royce

Page(s)	2 & 4
Paragraph	Multiple occasions
Comment #4	"extremely improbable" is repeatedly defined as "(10^{-9} failure per engine flying hour)" CS-E 15 Terminology defines Extremely Remote as "in the range 10^{-7} to 10^{-9}", therefore it would be more appropriate to define Extremely Improbable as range: 1) less than 10^{-9} failure per engine flying hour or 2) 10^{-9} failure per engine flying hour, or less
EASA position	Agreed
EASA response and proposed text	"10^{-9} failure per engine flying hour" replaced by: "10^{-9} failure per engine flying hour, or less"

Commenter 5: Rolls Royce

Page(s)	All
Paragraph	EASA Position
Comment #5	It is unclear what the ESF is actually compensating for. Is it that containment cannot be claimed/guaranteed for aerofoil release of greater than 80%, or that the test was less than 100% of the airfoil? I presume the former, because otherwise there seems little justification for the creations of a pseudo "Super-Critical part" requirement.

EASA position	Agreed
EASA response and proposed text	The reason for lack of direct compliance is clarified in the "Statement of issue": "The Applicant performed a fan IBR airfoil release test where at least 80% of the airfoil mass was released, with a release location well above the inner annulus flow path line. This was considered as meeting the minimum criteria of AWM 33.94 and FAR 33.94. Direct compliance to CS-E810 can however not be claimed as containment of the full airfoil and absence of subsequent Hazardous Engine Effect cannot be guaranteed.".

Commenter 6: Rolls Royce

Page(s)	3
Paragraph	EASA Position
Comment #6	The ESF states: "Consistent with CS-E515 for a part whose failure could result in a hazardous engine effect, the fan IBR airfoil under the demonstrated blade release location shall have in place…" Noting CS-E 515 applies specifically to Engine Critical Parts, it is noted that the ESF never mentions "Critical Part". Is it intended the airfoil below the demonstrated blade release location be considered part of the disc/drum (which will be a Critical Part) or separately treated as a critical part/section?
EASA position	Agreed
EASA response and proposed text	The airfoil is expected to be treated as an integral part of the disc/drum, which is a critical part. The text "*Consistent with CS-E515 for a part whose failure could result in a hazardous engine effect, the fan IBR airfoil under the demonstrated blade release location shall have in place…*" is replaced by "*As a feature whose failure could result in a hazardous engine effect, the Critical Airfoil Section shall be treated as an integral part of the IBR, which is an Engine Critical Part, when complying with CS-E 515 and hence be subject to:* a. an Engineerring Plan …."